Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

AMS Tracker Thermal Control Subsystem

QM FM Heat eXchanger Cleaning Procedure

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Document change log

Change Ref.	*Section(s)*	*Issue 1.0*
-	All	Procedure is partly based on PR-052
		Issue 2.0
	4.3	Clean the black surface
	5.2	Add Step 20 to 29
	5.2	Add additional clean check after sanding paper

Summary

This document describes the Heat exchanger cleaning procedure. The content includes the step 7, 9, 10 and 11, requested from the overall sequence of the HX manufacturing, as described in RD-2:

2. Cut soldering sheets in correct shape
3. Vacuum brazing stack of plates
4. Cover all entrances to avoid particle contamination
5. Measure the dimensions of the soldered stack of plates
6. Turning and machining of stack of plates to final dimensions
7. **Clean & cleaning check HX parts (stack of plates on outside, and container part)**
8. Vacuum brazing (lower temperature as previous brazing) stack of plates to housing
9. **Visual inspection after brazing on cleanliness**
10. **He-leak test to check stack to container solder**
11. **Visual inspection on cleanliness**
12. **Clean storage of brazed assembly**
13. **Cleaning before welding**
    a. **Cleaning check on combined brazed assembly**
    b. **Clean & cleaning piece 13.1 prior to welding**
14. Weld HX orbital welding according to AMSTR-NLR-PR-54

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(25 pages in total)

1 Scope of the document

The procedure in this document describes the cleaning procedure during Heat Exchanger integration steps.

2 References documents

	Title	Number	Date
RD-1	QM FM Heat Exchanger Brazing Procedure	AMSTR-NLR-PR-052-Iss02	July 2008
RD-2	TTCS Heat eXchanger design Report	AMSTR-NLR-TN-053 issue 1.0	February 2007
RD-3	Quality check procedure HX brazing test	AMSTR-NLR-PR-003	July 2007
RD-4	HX QM/FM Orbital welding procedure	AMSTR-NLR-PR-054	July 2008

3 Description of to be cleaned parts

3.1 Cleaning objective

The objective of the cleaning is to satisfy the cleanliness requirements as described in TTCS overall requirements document AMSTR-NLR-PL-02 TTCS Requirements Verification matrix LP-18a. In more detail the requirement is:

The maximum number of non-metallic particles in a 100 ml sample shall be as follows and is equivalent to MIL-STD-1246 C class 100:

- *> 100μm none*
- *100 μm 5 max*
- *50 μm 50 max*
- *25 μm 200 max*
- *10 μm 1200 max*
- *5 μm no limit*

To adapt to the AIDC available equipment the requirement is replaced by a value in TDS (Total dissolved solids).
The requirement is rephrased to:

- No visual particles in the residue sample
- TDS < 0.045 ppm

3.2 Cleaned parts before second brazing step

The parts for the second brazing step are shown in Figure 3-1.

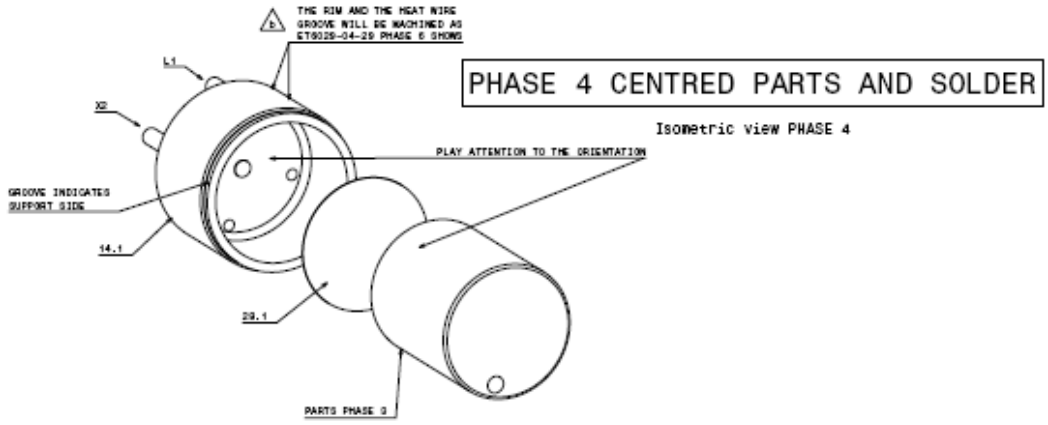
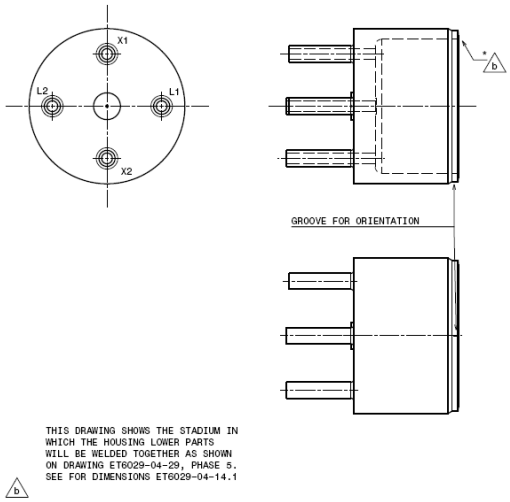


Figure 3-1: Second step brazing assembly

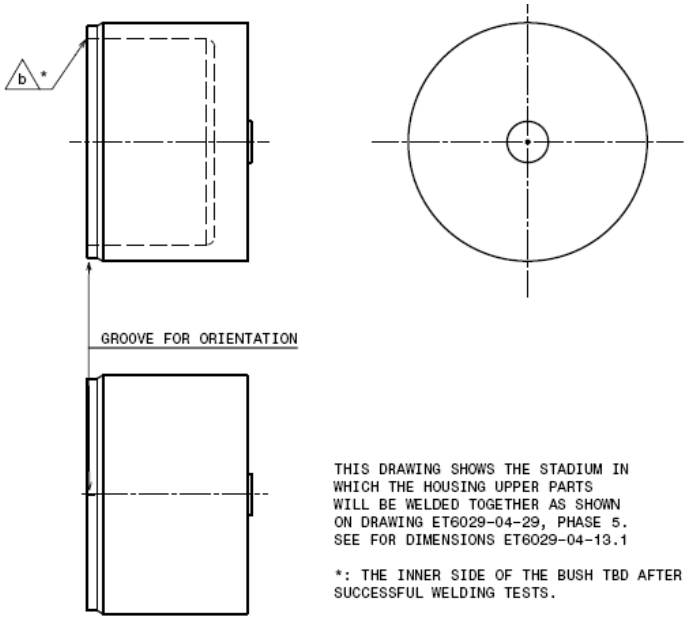


Figuur 3-2: Part 14.1 before brazing to stacked plates

3.3 Cleaned parts before welding step

After the brazing of the stack to the container part 14.1 to the stacked of plates another cleaning step will be performed prior to welding. The following parts are involved:

- Part 13.1 as shown below
- The assembled stack of plates brazed to housing 14.1
  (unassembled shown in Figure 3-1)



Figuur 3-3: Part 13.1 HX upper part housing

4 Cleaning & cleaning check

4.1 Cleaning & cleaning check of part 14.1

Clean part 14.1 with the steps of Table 4-1. **Don't use A-1-2(TURCO) to degrease parts**.

AEF-AIDC	表面處理施工說明書 OPERATION INSTRUCTION SHEET OF SURFACE TREATMENT	OIS. No. : GEC-011 Rev: E , Issue Date: 2007/04/12 Customer: GEAE

工作號碼(OP NO): N/A 工作部門(DEPT NO): 634 頁次: Page 2 of 5

件號: PART NO.	General Working Instruction	材料: MATERIAL	金屬材質(鎂合金除外) Metal Alloys (Except Magnesium Alloys)	規範: SPEC NO	---

用途(APPLICATION): [一般清洗、螢檢前清洗]及[螢檢後的清洗] ([General Cleaning,Cleaning Prior to FPI] and [Cleaning after FPI])

程序 SEQ. NO.	說明 DESCRIPTION	裝備 EQUIPMENT	溶液 SOLUTION	溫度(℃) TEMPERATURE	時間(分) TIME(MINUTES)	備註 REMARKS
A	**一般清洗 (General Cleaning)**					( )視需要 AS REQUIRED
(A-1-1)	溶劑除油 SOLVENT DEGREASE	# 00	MEK or ACETONE	室溫 R.T.	10秒以上 10 SEC min.	視需要,執行(A-1-1), (A-1-2) or (A-1-1)及(A-1-2) As required, perform (A-1-1), (A-1-2) or (A-1-1)&(A-1-2).
(A-1-2)	溶劑除油 SOLVENT DEGREASE	# 2	TURCO 3878 LF-NC	室溫 R.T.	10秒以上 10 SEC min.	
	冷水沖洗 SPRAY WASH	# 1	自來水 TAP WATER	室溫 R.T.	30秒以上 30 SEC min.	
A-2	熱鹼脫脂 HOT ALKALINE DEGREASE	# (3, 38 or 101)	Blue Gold 3-6% v/v	60±5℃ 140±10℉	10-15 分 10-15 MINUTES	確認所有表面均浸入熱鹼液內 ENSURE ALL SURFACES ARE DEGREASED
A-3	冷水沖洗 SPRAY WASH	# (6, 39 or 102)	自來水 TAP WATER	室溫 R.T.	30秒以上 30 SEC min.	
A-4	噴水並測試工件表面是否斷水紋,如未斷水紋則執行程序(A-5),如斷水紋則再執行程序A-2,A-3,A-4. WATER SPRAY AND CHECK FOR WATER BREAK FREE, IF BREAK FREE THEN SEQ. NO. (A-5), IF BREAK THEN REPEAT SEQ.NO.A-2,A-3,A-4.					
(A-5)	如發現表面有水痕殘留時,用手套沾蘇打以手洗方式清洗 If there exist water marks, hand cleaning with soda(Na_2CO_3).					
(A-6)	冷水漂洗 COLD WATER RINSE	清洗台 CLEAN PLATFORM	自來水 TAP WATER	室溫 R.T.	視需求 AS REQUIRED	
(A-7)	浸熱水 HOT WATER DIP	# 5	純水或去離子水 Pure/Deionized water	80℃ min. 176℉ min.	30秒以上 30 SEC MIN.	熱浸輔助乾燥 Hot dip to assist drying
A-8	除水份 REMOVE MOISTURE	純淨壓縮氣或烤箱(100±15℃; 30-60分) Filtered, oil-free compressed air or Oven(212±25℉; 30-60 minutes)				另件在放入烤箱烘烤前需吹乾 Hardware shall be blow-dried prior to putting in oven.

Table 4-1: Surface treatment sequence

After these steps put the part in a plastic cup with IPA as shown in Figure 4-1 and perform ultrasonic cleaning.

Figure 4-1: Ultrasonic cleaning in IPA

Check the cleanliness by:

- Visual inspection of the IPA (take a picture)
- If visual particles are shown repeat the ultrasonic cleaning with clean IPA
- Performing a TDS measurement < 0.045 ppm
    - Please consult the TTCS PM in case the value is not reached

4.2 Cleaning & cleaning check of stacked HX part

The part as shown in Figure 4-2 will follow a different cleaning scheme. After turning the following steps should be followed.

1. Perform all these steps in a clean room environment
2. Use gloves in all below steps
3. Keep all 5 holes closed with stops
4. Clean the outside surface with preferably IPA (or MEK) with a cloth
5. Remove the stops 1 by 1 and clean the surroundings with IPA (or MEK) with a cloth
    a. Pay attention no cloth is left in the opening
    b. Make pictures after cleaning
6. After these steps put the part in a plastic cup with IPA as shown in Figure 4-1 and perform ultrasonic cleaning.
7. Check the cleanliness by:
    a. Visual inspection of the IPA (take a picture)
    b. If visual particles are shown repeat the ultrasonic cleaning with clean IPA
    c. Performing a TDS measurement < 0.045 ppm
    d. Please consult the TTCS PM in case the value is not reached

After the cleaning check start brazing preparations for second brazing step as described in AMSTR-NLR-052 issue 2.

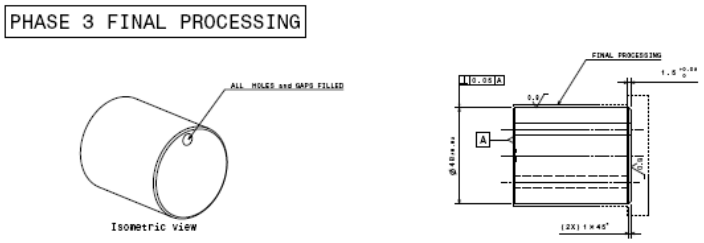


Figure 4-2: Second brazing part (Phase 3 in final processing)

4.3 Cleaning & cleaning check before welding

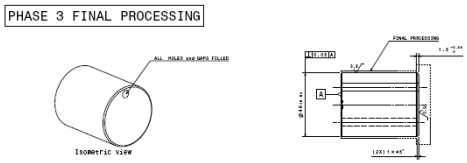
It is assumed the brazing of the two parts is performed in a clean environment and the brazed assembly is cleanly handled. After brazing first a visual check on the cleanliness is done. If contamination is found the TTCS PM need to be informed and an additional cleaning step will be defined.
After a successful visual inspection or an additional cleaning step, first a Helium leak test is performed to check the brazing between stack and container. Then the parts are stored in a clean environment in a bag.
Prior to welding a second visual cleanliness check on the stack assembly is done, clean the black surface (cause of brazing stop-off agent) and part 13.1 is cleaned according to the standard procedure and checked on cleanliness.

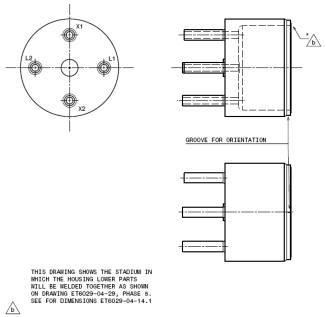
If preferred cleaning of part 13.1 can be done in parallel with part 14.1 and cleaning check of the stacked and brazed container can be done.

5 Cleaning procedure in steps

5.1 Cleaning before brazing

	HX Cleaning before brazing		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Record model (QM /FM) which will be cleaned	Model	-			
2.	Perform all steps in a clean room environment. Record class of the clean room.		e.g. 10,000			
3.	Perform all steps with gloves					
4.	Record cleaning agents used		IPA			
5.	Record cleaning cloth used					
6.	Check if all 5 holes of brazed stack of plates are still covered by stops. If not contact TTCS PM on how to proceed.		Yes/no			
7.	Clean outside of the stack with cloth and IPA					

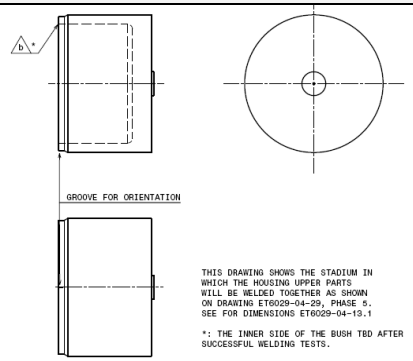
	HX Cleaning before brazing		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
						
8.	Take out the stop(s) one by one and clean with IPA with a cloth. Perform this step with the hole facing down.					
9.	Check if no cloth is left in the opening					
10.	Repeat steps 8 and 9 five times					
11.	Take a picture of the result and document electronically					
12.	Put the assembly in a plastic cup with high purity and clear IPA					
13.	Perform ultrasonic cleaning as shown in Figure 4-1					
14.	Perform visual inspection of the IPA, take a picture and document electronically. If visible particles are present repeat step 12-14.					

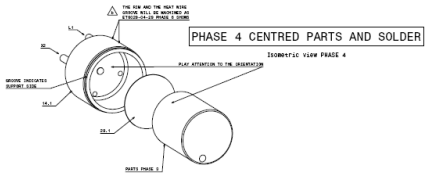
	HX Cleaning before brazing		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
15.	Perform TDS measurement with equipment as shown in Appendix I. If TDS > 0.045 ppm repeat 11-14. Consult TTCS PM when value stays above 0.045 ppm					
16.	Blow oil-free and filtered (10 µm) air, gaseous nitrogen, or argon gas to dry the stack					
17.	End cleaning brazing stack					
18.	 Cleaning part 14.1					
19.	Clean part 14.1 according to Table 4-1					
20.	Put the part 14.1 in a plastic cup with high purity and clear IPA					

	HX Cleaning before brazing		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
21.	Perform ultrasonic cleaning as shown in Figure 4-1					
22.	Perform visual inspection of the IPA, take a picture and document electronically. If visible particles are present repeat step 12-14.					
23.	Perform TDS measurement with equipment as shown in Appendix I. If TDS > 0.045 ppm repeat 11-14. Consult TTCS PM when value stays above 0.045 ppm					
24.	Blow oil-free and filtered (10 µm) air, gaseous nitrogen, or argon gas to dry the stack					
25.	End cleaning before brazing					
26.	If brazing is started immediately start with procedure AMSTR-NLR-PR-052-Iss02 (the stack to container part)					
27.	If brazing starts later. Perfrom steps 26 to 28.					
28.	Put part 14.1 in a clean bag, seal and store in a clean and dry environment					

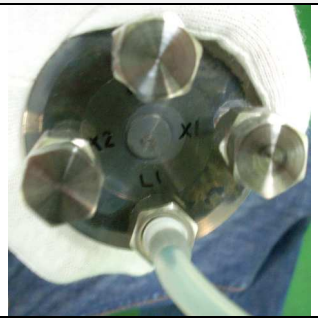
5.2 Cleaning before welding

	HX Cleaning before welding		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Record model (QM /FM) which will be cleaned	Model	-			
2.	Perform all steps in a clean room environment. Record class of the clean room.		e.g. 10,000			
3.	Perform all steps with gloves					
4.	Record cleaning agents used		IPA			
5.	Record cleaning cloth used					

	HX Cleaning before welding		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
6.	 **Cleaning part 13.1**					
7.	Clean part 13.1 according to Table 4-1					
8.	Put the part 13.1 in a plastic cup with high purity and clear IPA					
9.	Perform ultrasonic cleaning as shown in Figure 4-1					
10.	Perform visual inspection of the IPA, take a picture and document electronically. If visible particles are present repeat step 12-14.					
11.	Perform TDS measurement with equipment as shown in Appendix I. If TDS > 0.045 ppm repeat 11-14. Consult TTCS PM when value stays above 0.045 ppm					

	HX Cleaning before welding		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
12.	Blow oil-free and filtered (10 µm) air, gaseous nitrogen, or argon gas to dry the stack					
13.	End of cleaning part 13.1					
14.	**Cleaning check on brazed stack after He-leak test** 					
15.	After brazing two checks are performed.					
16.	Check with brazing engineer if brazing has been performed clean enough to fulfil the requirements in section 3.1. If no consult TTCS PM how to proceed. If yes continue with step 17.					
17.	Put brazed stack on a clean white piece of cloth with the tubes facing in the air. Tap with a clean TBD instrument on the top side in between the tubes.					

	HX Cleaning before welding		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
18.	Check if any particles are found on the white piece of cloth. If particles are found check with TTCS PM how to proceed.					
19.	If no particles are found perform a visual check with a (clean!!) light. If particles are found check with TTCS PM how to proceed, else go to next step					
20.	**Clean surface of brazed stack**  					
21.	Make sure all entrances are closed by Swagelok cap & tape.					
22.	Connect tube to L1 with oil-free filtered (10 µm) air, gaseous nitrogen, or argon gas.					

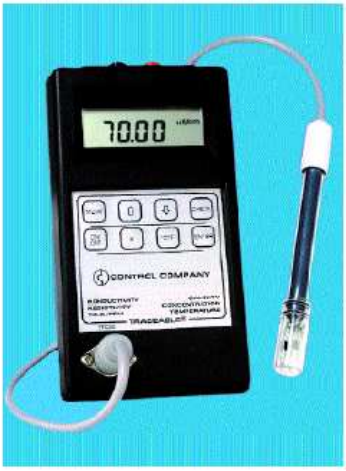
	HX Cleaning before welding		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
						
23.	Open the only one hole on cleaned surface.					
24.	Adjust gas pressure to reasonable flow. (make sure there is gas come out from the hole)					
25.	Use #600 or #400 sandpaper to polish the surface.					
26.	Clean surface using clean cloth with IPA.					
27.	Repeat Step25 & 26. Until the surface become clean.					
28.	Disconnect the tube and close by cap. Close the hole of cleaned surface using tape.					

	HX Cleaning before welding		company:		date:	
	Fill in by hand.		engineer:		location:	
Step	Action	Monitoring	Value	**Result**	Comment	√
29.	Put brazed stack on a clean white piece of cloth with the tubes facing in the air. Tap with a clean TBD instrument on the top side in between the tubes.					
30.	Check if any particles are found on the white piece of cloth. If particles are found check with TTCS PM how to proceed.					
31.	If no particles are found perform a visual check with a (clean!!) light. If particles are found check with TTCS PM how to proceed, else go to next step					
32.	Put part in a clean bag, seal and store in a clean and dry environment					
33.	Continue with orbital welding procedure described in AMSTR-NLR-PR-054					
34.	End cleaning before welding.					

Appendix 1: Cleaning Equipment

Traceable® Portable Conductivity Meter

Quick answers, accurate results on demand
Measuring conductivity quickly doesn't mean sacrificing accurate results or product purity. In an instant, Portable Bench Conductivity Meter automatically selects the proper range and displays the exact answer without hassles. This auto-ranging feature may be turned off to accommodate user-entered ranges. All special calibration data is saved even when turned off. Fulfills all government measurement requirements plus CAP, ASTM, NCCLS, and ACS.



Range in micromhos is 0.01 to 200,000, in megohms is 0.001 to 20.000, range in dissolved solids/parts per million is 0.1 to 20,000 and in salinity is 2.0 to 42.0 (oceanographic units). Accuracy is ±0.3%.

Four calibration points may be entered into memory utilizing solution standards
Results are displayed in conductivity (micromhos/cm and microsiemens/cm), resistivity (megohms), dissolved solids (parts per million), concentration (user-specified units), salinity (oceanographic units), and temperature (F/C). Probe is 5¼ x ½ inches in diameter with a cable length of 59 inches. Temperature compensation is automatic (2% per °C), user-designated (0.000 to 5.000% per °C), or absolute. K-factor may be adjusted to match each probe. Plastic accessory probe is available.

Supplied instant-response probe contains platinum electrodes that deliver highly accurate readings
Internal solid-state thermistor (for automatic/manual temperature compensation) permits all readings to be referenced to the international standard of 25°C. Exclusive "temperature compensation disable function" fulfills USP-NF (United States Pharmacopoeia, National Formulary, 645 Conductivity Measurement) requirement. Use to check the purity of water from stills and demineralizers; to analyze seawater; and to make up solutions. Simply turn on, insert probe, and read–easiest unit ever designed for routine analysis, quality control, and research. Elimination of "operator technique" permits everyone in the lab to report identical readings. Tough, chemical-resistant ABS housing assures a long life in severe lab or harsh plant environments. Large ½-inch-high LCD digits are easy to read.

Traceable® to NIST
To assure accuracy, a certificate is provided to indicate instrument traceability to standards provided by NIST (National Institute of Standards and Technology) from our ISO 17025 calibration laboratory.

Permanent hard copy record
Recorder jack allows continuous monitoring and a permanent record. Adjustable control allows unit to be calibrated to solution standards.

Unit size is 3¾ x 6¾ x 1½ inches. Weight is 16 ounces. Battery is supplied. Replacement battery Cat. No. 1112.

Cat. No. 4063 Traceable® Portable Conductivity Meter

Cat. No.	ACCESSORIES
4062	Replacement Conductivity Probe– Glass, K=1 Probe range is 0.05 to 200,000 micromhos.
4061	Accessory Conductivity Probe– Unbreakable Epoxy, K=1 Probe range is 1.0 to 200,000 micromhos.

(For a list of accessory Flow-Thru Cells see Page 8)

TRACEABLE DIGITAL CONDUCTIVITY METERS

Cat. No.	4063	4163	4168	4169	4070	4075
Description	Portable	Bench	H20 Tester	Dual-Display	Portable	Expanded Range
Range Micromhos/Microsiemens	0.01 to 200,000	0.01 to 200,000	0.1 to 20,000	0.1 to 20,000	0.01 to 200.0	0.01 to 200,000
Range Megohms	0.001 to 20.000	0.001 to 20.000	N/A	N/A	2.00 to 20.00	N/A
Range Dissolved Solids/Parts Per Million	0.1 to 20,000	0.1 to 20,000	N/A	N/A	N/A	0.1 to 120,000
Range Salinity/Oceanographic Units	2.0 to 42.0	2.0 to 42.0	N/A	N/A	N/A	N/A
Accuracy	±0.3%	±0.3%	±0.4%	±(2% full scale +1 digit)	±0.4%	±0.4%
Temperature Compensation	Auto and manual	Auto and manual	Automatic	Auto and manual	Automatic	Automatic
Output	Recorder	Serial	None	Serial	None	Recorder
Size/Inches	3.75x6.75x1.5	8.25x6x3.5	6.25x3.2x1.33	7x3x1.25	3.25x4.5x1.5	5x2.25x5.75

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